Building Confidence in Pipeline Safety

The role of management systems in achieving our goal of zero incidents

An INGAA IMCI White Paper
October 2012

Table of Contents

Authors

Tracey Scott, Alliance Pipeline Ltd.
Stacey Gerard, P-PIC
Brianne Metzger-Doran, Spectra Energy Transmission
Mark Hereth, P-PIC

Champions

Andy Drake, Spectra Energy Transmission
Mark Milliken, Southern Union Gas
Mike McGonagill, Alliance Pipeline Ltd.
Harold Kraft, Alliance Pipeline Ltd.

Contributors and Reviewers

Royce Brown, Centerpoint Energy
Greg Nadauld, Questar Energy
Susan Waller, Spectra Energy Transmission
Grant Cirka, TransCanada Pipeline
Joe Neave, Williams Energy
Glenn Lafitte, ONEOK
Michelle George, Union Gas
Dave Chittick, TransCanada Pipeline
Gordon Simmonds, TransCanada Pipeline

I. Introduction

The intent of this white paper is to provide INGAA members with a framework of recommendations for the next evolution of integrity management based on the management system elements in ASME B31.8, B31.8S and current regulations. The recommendations included in this paper are flexible by design and draw upon the experience of industries that have a risk profile that includes high consequence, low probability events. Operators that have a basic management system built around the B31.8S elements will be able to use this white paper to chart a course to move to the next level, recognizing that any management system must be fit for purpose and fit for the company's culture.

Programs related to Integrity Management (IMP), Health Safety and Environment (HSE) (including Emergency Management/Incident Mitigation Management), Control Room Management, and Quality Management (QMS) form barriers; layers of defense to incidents. Research indicates that organizational accidents rarely occur due to the breakdown of a single program; usually, it is the alignment of weaknesses across multiple programs that enables compound conditions to result in a high consequence event. Work to make these programs more effective, comprehensive, systematic and integrated is work to reduce the risk of organizational accidents.

This paper includes a brief background on management systems, the principles of making them work, a framework for measurement and the concept of a maturity model intended to allow operators to identify where they are in the evolution of the management system approach and to make choices where they want to go over the next several years.

II. Why Focus on Management Systems

In the aviation, nuclear, chemical, medical, food safety industries, where low probability/high consequence events are unacceptable in operations, the public demanded significant reduction in failures or incidents. These industries made the choice, or it was made for them, to adopt a management systems approach because they recognized that it is not practical to envision and develop procedures for all possible adverse events and because this approach enabled them to:

- Meet expectations of customers, employees, shareholders and the public
- Achieve more comprehensive integration and alignment with goals, policy, programs and processes linked to planned resource allocation
- Improve operational effectiveness and efficiency in a way that is continuous and sustainable
- Achieve multidimensional performance – i.e., economic, socially-responsible and operationally effective

The pipeline industry's recognition of the value of the management systems approach is not new. ASME B31 and B31.8S have been guides to a management system approach for ten years; and government and industry associations that have been and are currently focusing on management systems include NTSB, DOT, NEB, AGA, CEPA and INGAA.

Increasingly management systems are seen as a framework for mitigating risks that arise from both straightforward and complex failure modes.

III. Management System Defined

This white paper defines management systems as a framework of policies, processes, procedures applied by people, enabled by technology to ensure that an organization can fulfill all tasks required to achieve its business objectives. A management system enables people to execute tasks using risk management with established controls to meet the business objectives. Computer systems are tools that enable management systems but are not the management systems themselves.

The intent of management systems is simply to improve standard "business management" by adding systematic and coordinated discipline and structure as well as better feedback loops on the effectiveness of risk management and other processes.

Most management systems are based on the continual improvement cycle of "Plan, Do, Check, Act":

- Plan: Plan the work to be done
- Do: Complete the work
- Check: Evaluate and monitor the work
- Act: Improve and integrate lessons learned

The "Act" or "Improve" part of the cycle is often missing from traditional management. This aspect—the idea of learning from current practices, incidents, monitoring data, etc. and using learnings to identify opportunities for improvement —is a key to making a management systems effective and valuable in continuously improving performance.

Frequently the term "Safety Management System" is used to denote operations management systems. The term generally refers not only to management of personal safety, but also to management of asset integrity and process safety. Also, in certain areas (such as material selection), the term "Quality Management System" is frequently used—this builds off the origin of management systems, when the focus was primarily on quality of manufactured goods. Quality management now frequently appears as a subset of many of management systems. For the purposes of this white paper, the scope of the management system includes integrity programs, the processes for optimizing asset maintenance, operations and safety performance.

The National Transportation Safety Board (NTSB) placed Safety Management Systems on their "most-wanted" list in 2011. Based on three decades of incident investigation, NTSB feels strongly that robust Safety Management Systems (SMS) could have prevented many of these incidents. NTSB defines a SMS as follows: "SMS is the formal, top-down business approach to managing safety risk, which includes a systemic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures. (Order VS 8000.367)"

They also explain the benefits as follows:

> "By recognizing the organization's role in accident prevention, SMSs provide to both certificate holders and FAA:
>
> - A structured means of safety risk management ***decision making***
> - A means of demonstrating safety ***management capability*** before system failures occur
> - Increased confidence in ***risk controls*** though structured ***safety assurance*** processes
> - An effective interface for ***knowledge sharing*** between regulator and certificate holder

- A ***safety promotion*** framework to support a sound ***safety culture"***

(citation: http://www.faa.gov/about/initiatives/sms/explained/)

IV. The Elements of a Management System and Comparison of Standards

There are a variety of management systems standards that can serve as valuable references for pipeline operators.

In the following table, management system standards that have been developed by government, industry and international organizations are compared to a defined set of management system elements. The table illustrates the consistency between selected standards and, by comparison illustrates opportunities for improvements to B31.8S.

The management system standards were chosen for inclusion based on the following:

- The regulatory requirements / consensus standards are those that either directly relate to the pipeline industry (ASME B31.8S-2010 and CSA Z662-07) or that include elements that are recommended in this white paper (FAA).
- The international standards are those that are used by some operators (ISO 14001, ISO 18001) in their management processes. In addition, the PAS-99 standard from the British Standards Institute was included because it provides a model of an integrated approach to management systems design and implementation. PAS-55, also from BSI, is included as it was developed specifically for asset integrity management, and has been incorporated into the ISO standards process with an anticipated release as ISO 55000 in 2013.
- The industry standards are from the oil and gas industry include ExxonMobil's OIMS standard because it is long established and widely publicized, and has served as a benchmark for many companies in the oil and gas industry. Chevron's OEMS is included because it has been applied throughout the corporation, including the pipeline assets, since the mid-1990s.

Table 1 Comparison of Various Management System Standards

Management System Elements	Regulatory Requirements / Consensus Standards			International Standards				Industry Standards		
	ASME B31.8S-2010	FAA	CSA Z662-11	ISO 14001:2004	BS OHSAS 18001: 2007	PAS 99:2006 Integrated Management Systems	PAS 55 Asset Management	API RP 75	ExxonMobil OIMS	Chevron OEMS
1.0 Management commitment		x	x	x	x	x	x	x	x	x
2.0 Management Review	o	x	x	x	x	x	x	x	x	x
3.0 Stakeholder engagement	x	o		x	x	x	x	x	x	x
4.0 Responsibility, accountability and authority (applied to each process)	o	x	x	x	x	x	x	x	x	x
5.0 Risk management	x	x	x		x	x	x	x	x	x
6.0 Safety culture		x			o			o	o	x
7.0 Work force planning, training, development and qualification	x	x	x	x	x	x	x	x	x	x
8.0 Engineering and construction	x		x				x	x	x	x
9.0 Learning culture and continuous improvement	o	x	o	o	o	o	o	x	x	x
10.0 Management of change	x	x	x		x		x	x	x	x

Management System Elements	Regulatory Requirements / Consensus Standards			International Standards				Industry Standards		
	ASME B31.8S-2010	FAA	CSA Z662-11	ISO 14001:2004	BS OHSAS 18001: 2007	PAS 99:2006 Integrated Management Systems	PAS 55 Asset Management	API RP 75	ExxonMobil OIMS	Chevron OEMS
11.0 Quality assurance and quality control	x	x	x					x	x	x
12.0 Performance measurement	x	x	x	x	x	x	x	x	x	x
13.0 Incident investigation and lessons learned	x	x	o		x	x	x	x	x	x
14.0 Emergency preparedness and response	x	x	x	x	x	x	x	x	x	x
15.0 Documentation and records management	x	x	x	x	x	x	x	x	x	x

Legend:

x = the element is covered explicitly in the compared standard.
o = the element is partially covered in the compared standard, but is not explicitly or completely addressed.
Blank = the element is not addressed in the compared standard.

V. Critical Success Factors

There are a number of critical factors that determine the likelihood of successful development, implementation and sustainment of a management system.

The Long View

As management system implementation is not a short-term project, and does not necessarily have immediately quantifiable or visible impacts, it can be difficult for companies to stay on the journey and realize the ultimate benefits of more systematic management of risk. Executive commitment to implementing, sustaining and actively using the management system must be consistent and enduring.

Iterative Approach

Just as management systems are intended to provide a framework for continuously improving operations performance, the framework and the structure of the management system itself also needs to evolve and improve as it becomes a fundamental part of the business model.

Planned reviews of the management system's overall effectiveness and maturity, i.e., extent to which the program is comprehensive, systematic and integrated, and its alignment with organizational priorities and culture provide information on what to focus on next in keeping the management system valuable and making it ever more effective and efficient.

Interaction of Safety Culture and Management Systems

Organizational culture needs to support the discipline necessary for effective implementation of the management system; to capture the value that management systems produce. Indications of that culture include raising risks openly, reporting consistently, a watchfulness for a 'conspiracy of optimism', i.e. a cultural predisposition to minimizing threats, and keeping focus on the goal of zero incidents.

Design That is Fit For Purpose and At The Right Level Of Maturity

Organizations must design and implement management systems in a way that works with their culture, structure, and core values as well as building on existing programs and processes. Furthermore, few companies can develop and implement a management system in a year or two. It takes time to integrate systematic management principles into the culture and close attention must be paid to pace and the organization's capacity to implement. Consequently, while management system elements are largely consistent across the various standards, management systems in each organization will likely be structured differently.

VI. Recommendations

With one exception each of the following recommendations focuses on strengthening the elements of B31.8S that are already in place. The recommendations provide specific, tangible actions for operators to consider as they assess their own management system maturity and identify their next priority for improvement.

In addition to assuming the critical success factors are considered, recommendations are based on the following assumptions:

- INGAA members currently use B31.8S and the regulations including all parts of 49 CFR 192 to guide integrity activities.
- Companies may have multiple management systems (e.g., IMP, HSE, QMS) or a single integrated management system.
- Operators will choose what to focus on based on their organizational priorities, risks and management system maturity.

Management Leadership and Commitment

Management Leadership and Commitment is defined as "The operator leadership has defined a safety policy, communicates expectations and objectives, makes and monitors commitments, and advocates consistently that everyone is accountable for safety." *This is represents the Plan" phase and the "Act" phase.*

Recommendation:

Operators consider adding a specific separate element called Management Leadership and Commitment to their management system. This includes:

- Broadening safety policy to include asset safety and the importance of identifying, assessing, mitigating or accepting risks raised by any employee.
- Expanding commitment to communications with stakeholders beyond achieving awareness to achieving engagement in identifying and reducing risks to people and the pipeline.
- Fostering an organizational environment that follows the policy; hearing all safety issues, reporting all events whether near misses or incidents, learning lessons from events through comprehensive system evaluation.
- Committing to systematic, consistent, formalized planning activities, evaluating performance and effectiveness (senior management review), and making decisions for course correction or for improvement opportunities.
- Including pipeline safety as a performance metric at the executive level to foster awareness of asset safety and performance and to ensure appropriate support for integrity and safety programs
- Ensure accountabilities and responsibilities are established to support the policy and align incentive systems to support policy and management system elements.

Integrity Management: Build on B318.S for a Strong Foundation for Integrity Management Improvement

Building upon the integrity management principles in B31.8S is defined as "The operator develops and maintains a comprehensive process to understand the critical characteristics of its assets, facilities, systems and operations and applies this knowledge to identify hazards; analyze and assess risk; design and implement risk controls and other preventive and mitigative measures; and measure performance effectiveness and act on identified gaps." *This is represents the "Do" phase.*

Integrity management (the set of processes to manage integrity related threats) as defined by B31.8 and B31.8S is similar to the other models of risk management reviewed and contains many of the management system elements.

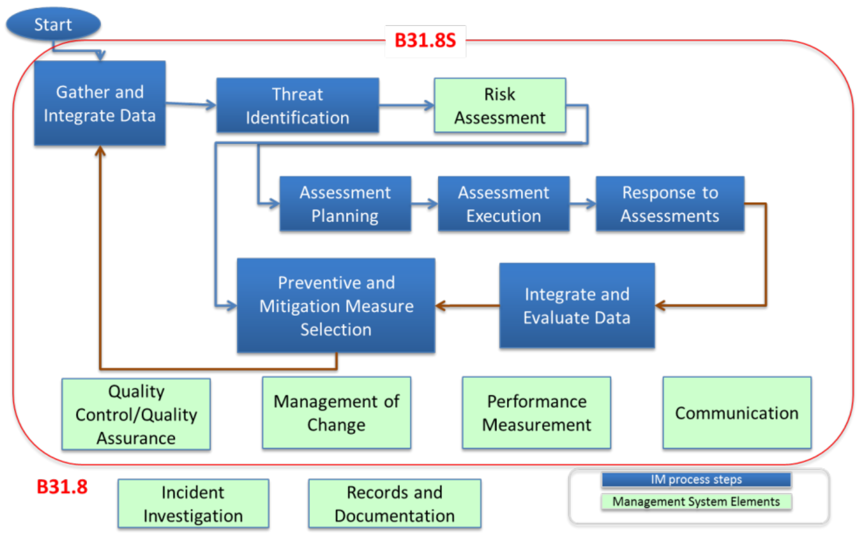


Figure 1 – Integrity Management Processes

Reviewing incident history and considering input from a range of stakeholders on the public docket [PHMSA Docket 2011-0023] and the NTSB docket of pipeline accident reports, there are opportunities for our industry to improve risk analysis, particularly interactive threats, technology applications, data integration, and anomaly management. In prevention and mitigation, there are opportunities to improve assessment of interactive consequences, physical facilities and operating practices. This includes extending integrity management to protect all people along the pipeline system. INGAA's Integrity Management Continuous Improvement (IMCI) teams are developing guidance to identify improvements in these areas and to provide considerations for how to extend protection system wide.

Recommendation:

Operators develop a long term continuous improvement plan for their management system considering:

- Assessing each element of the management system to determine how comprehensive, systematic and integrate it is and set associated improvement goals
- Assessing applicability and timing of adopting IMCI Team guidance on:
    - Risk assessments, interaction of multiple threats and technology selection appropriate to the threats. This includes consideration of the work of the Gas Technology Institute on the interaction of multiple threats.

- o Standardizing anomaly management throughout the pipeline system, extending responses outside of High Consequence Areas.
- o Expanding the use of data integration so that it is integral to the steps in the integrity management process depicted in Figure 1.
- o Improving records management.
- o Defining and implementing processes for management of pre-regulation pipe
- o Applying technology advancement for assessment, prevention, mitigation.
- o Improving incident mitigation management by undertaking risk driven evaluation of consequences to identify opportunities for improvements in facility and operational practices; implement actions to improve response in populated areas.

Safety Assurance

Safety Assurance is defined as "Operator develops and maintains a means to monitor, measure and verify safety and integrity performance and to validate effectiveness of risk controls."   This is represents the "Check" phase.

This includes the following elements of B31.8, B31.8S and regulation;

- quality control
- incident investigation
- data analysis
- management of change
- continuous improvement
- performance planning and measurement and
- communication

Safety assurance relies on data collection and integration; having traceable, verifiable and complete records during threat assessment, risk assessment and the associated decision making processes.

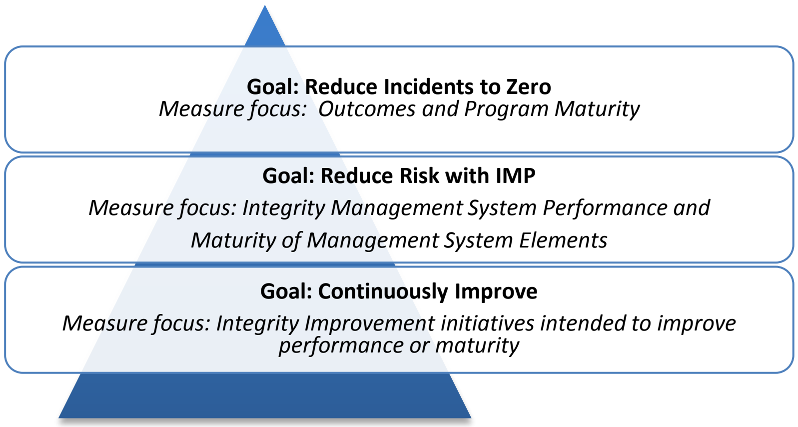
Recommendation:
Operators consider:

- Assuring objectivity of evaluations through periodic internal and external audits, and peer reviews of the integrity management program.
- Providing more formality and specificity of the audit program, specifically, assigning a dedicated qualified resource (auditor), defining and accepting a standard audit criteria and process which includes documentation of audit results.
- Including results from audits and peer reviews as an input into senior management reviews of the integrity management program.
- Recording and tracking the implementation of decisions to correct or improve the management system.
- Establishing and utilizing high level performance measures as an input into senior management reviews to demonstrate improving integrity management effectiveness over time; that risk is being driven down.

Recommended Framework for Measures

- Provide executives with measures on program safety outcomes. Support that information with measures on program performance and the status of initiatives intended to improve performance and, by extension, outcomes.

- Measures of safety outcomes include incidents, property damage, injuries and fatalities.
- Measures of program execution and effectiveness include measures relating to assessment, findings and response activities.
- Measures of maturity include indicators of how much of the asset and asset lifecycle the program applies to, how consistently the program is executed and how consistently the program shares and utilizes information with other programs.
- Indications of gaps or opportunities relating to effectiveness or maturity are used as inputs in deciding where to focus improvement efforts. Measures of improvement initiatives include status of development, deployment and measurement.



VII. Getting Started and Assessing Maturity

A review of other industries' moves towards management systems reveals the following lessons:

- Set out with a common goal; a clear commitment to improve performance steadily over time. Make it a fundamental part of the business model.
- Start small with a focus on turning data into good information to fuel good decisions on opportunities to improve.
- Evolve over time. Build on a common set of elements, link goals, processes and resources
- Establish active, visible executive sponsorship and support that with clear links to strategy, policy, programs, accountability, a strong culture, stakeholder engagement among others.
- Work to accommodate disparate existing systems, synchronize different requirements, and implement improvement in an increasingly comprehensive, integrated and systemic way.
- Foster participation recognizing the varying levels of management system maturity.

Maturity Model Framework

To help operators chart a course to move to the next level of management system, we begin with the recognition they possess a range of capabilities. In a separate document, we intend to provide flexible guidance enabling operators to choose their priorities for progress at a rate appropriate to their company over several years. We will build a set of indicators for each Element recommendation. Indicators show evolution within a structure that embodies the qualities of "comprehensive, systematic and integrated" within an IMP. We define three stages: the development of a conceptual approach, deployment undertaken, and measurement of results. Chief executives will be able to use this basis for management review of continuous improvement.

There are several objectives for the maturity assessment guidance. First, we provide a road map to move process and practice to a higher level of effectiveness. It will guide management to put good solutions into operation. With suggested indicators provided, an operator should have an objective means to determine its maturity level. Guidance should provide the right level of focus to various elements. It can serve as a model for periodic review of people, processes and technology effectiveness, including coordinating with vendors/contractors and other outside relationships to achieve a mutual understanding of expectations. It should address if the technology environment is up to the task of performing required processes and if changing needs are evaluated periodically and appropriately. Finally, it could lead to a basis for validating a performance-based approach to managing risk in pipelines.

VIII. Appendices

Linking Recommendations to Standards and Regulations

The following table is intended to align the recommendations with the standards and regulations.

Element	B31.8S Standard	CFR 192 and Gas Integrity Management Inspection Manual : Inspection Protocol with Supplemental Guidance, Jan 1, 2008, Rev. 5	Recommendations for Management System
I. Management Leadership & Commitment *The "Plan" phase in PDCA, and eventually the "Act", after feedback from the Check Phase in Element III.*	No Explicit Requirement	Executive Signature Required on Annual Report	Operator Leadership has defined safety policy, communicates expectations & objectives; makes & monitors commitments; advocates consistently everyone is accountable for safety. Broaden safety policy to include asset management and the importance of identifying, assessing, mitigating or accepting risks raised by any employee. Foster environment of hearing all safety issues, learning lessons from events through comprehensive system evaluation; balance between productivity and protection. Commit to systemic, consistent, formalized planning, evaluating performance effectiveness Management values pipeline as long term metric.
II. Integrity Management, the "Do" phase in PDCA model.	1.2 Purpose: comprehensive, systematic and integrated IMP program provides the means to improve safety Performance based IMP utilizes more data and more extensive risk analyses 1.3 Principles: Information integration is a key component... key element is the integration of all pertinent	C02 Data Gathering & Integration Verify that the operator gathers and integrates data and information on the entire pipeline… verify that the necessary data have been assembled and integrated. 192.917 (b) An important distinction to consider when inspecting for the requirements related to this protocol is the difference between data INTEGRATION and data AGGREGATION. Operators	Improve risk analysis, including: • review of interactive threats, • technology applications, • assessment of interactive consequences per valve segments, • data integration, • anomaly management, • Physical facilities impacting populated areas and operating practices involved in incident recognition and response. Extend integrity protections per IMCI Team 2 stated goals; conduct a review of how threats potentially interact,

Element	B31.8S Standard	CFR 192 and Gas Integrity Management Inspection Manual : Inspection Protocol with Supplemental Guidance, Jan 1, 2008, Rev. 5	Recommendations for Management System
	information when performing risk assessment... this analytical process involves the integration of design, construction, operation, maintenance, testing, inspection and other information about a pipeline system. Assessing risks to integrity is a continuous process. New technology should be evaluated and implemented as appropriate…as it becomes proven and practical. 2. Overview: Performance based IMP requires more knowledge and consequently more data intensive risk assessment and analyses. 2.2 Threat Classification: Each of 22 causes represents a threat that shall be managed. Other than unknown, the remaining group into nine categories. The interactive nature of threats, more than one threat occurring on a section of pipeline at the same time, shall be considered. 2.3.2 Gathering, Reviewing and Integrating Data: Information on the operation, maintenance,	should not simply put several types of information into a single location and assume that such an exercise constitutes data integration. The most important aspect of data integration is the ANALYSIS of aggregated data in order to discern integrity threats and risks that would not otherwise be observed from independently reviewing the various individual data elements. The operator's process should address how it does both data aggregation and data integration F Continual Evaluation and Assessment Verify the operator conducts a periodic evaluation of pipeline integrity based on data integration and risk assessment to identify threats specific to each covered segment and the risk represented by these threats. 192.917 and 192.937 (b) F 01b Periodic Evaluation Verify that periodic evaluation of data is thorough, complete and adequate for establishing reassessment methods and schedule. (192.937 (b) F01 b. Review the IM Program to determine if it contains requirements to conduct periodic integrity evaluations that are technically rigorous, justifiable and adequate for making integrity related decisions. F01 d. Verify that the operator periodically reviews the processes	determine best assessment technology and apply. Upgrade anomaly management outside HCAs consistent with inside HCAs, improve records management and pre-regulation pipe per team 4. Review and track key elements at leadership level (see Element 1) and formalize validation/safety assurance process (see Element 3) per team 6 Apply technology advancement for assessment prevention and mitigation, including following technology selection advice appropriate to the threat, coming next year from Team 2. Develop and implement Incident Mitigation Management plans per Team 7 to address consequence factors in risk assessment and control more comprehensively and to shorten response time to one hour or less in populated areas. Identify and implement improvements opportunities in facility and operational practices, including automation of valves where needed to meet response objectives.

Element	B31.8S Standard	CFR 192 and Gas Integrity Management Inspection Manual : Inspection Protocol with Supplemental Guidance, Jan 1, 2008, Rev. 5	Recommendations for Management System
	patrolling, design, operating history and specific failures and concerns that are unique to each system and segment will be needed. 2.3.3 Risk Assessment: Integrated evaluation of information and data in the risk assessment process identifies the location-specific events and/or conditions that could lead to a pipeline failure and provides an understanding of the likelihood and consequences 2,3.5: Responses to Assessment, Mitigation (Repair and Prevention) Repairs are performed in accordance with accepted industry standards and practices 3. Consequences: The operator shall consider consequences of a potential failure when prioritizing inspections and maintenance activities. 3.3 Consequence Factors: When evaluating consequence of a failure within the impact zone, the operator shall consider population density, proximity, limited mobility populations, property and environmental damage,	and risk assessment methods used to develop the evaluations to ensure they continue to yield relevant, accurate results consistent with the objectives of the operator's overall integrity management program. Adjustments and improvements to the risk assessment methods will be necessary as more complete and accurate information concerning pipeline system attributes and history become available. Identify relevant changes to the pipeline system and verify that this new information was evaluated for potential impact on evaluation results (i.e., reassessment intervals and methods). Determine if the conclusions regarding the potential impact were appropriate. H07a. Automatic Shutoff Valves on Remote Controlled Valves. Verify that the operator has a process to decide if automatic shutoff valves or remote control valves represent an efficient means of adding protections to potentially affected high consequence areas. 192.935(c) Each operator's IMP should include a risk analysis-based process describing methodology for determining if an automatic shut-off valve or remote control valve should be added. As a minimum, the following factors must be included in the process: • swiftness of leak	

Element	B31.8S Standard	CFR 192 and Gas Integrity Management Inspection Manual : Inspection Protocol with Supplemental Guidance, Jan 1, 2008, Rev. 5	Recommendations for Management System
	unignited gas, security of gas supply, public convenience, potential for secondary failures 4.5 Data Integration: Major strength lies in ability to merge and utilize multiple data elements obtained from several sources to provide improved confidence that a specific threat may or may not apply to a pipeline segment 5.12 Risk assessment validation: Ensure that methods have produced results that are usable and consistent with operator's and industry's experience… process shall be identified and document. 7.1 Responses to Repair and Prevention: Provide analyses of existing and newly implemented mitigation actions to evaluate their effectiveness and justify their use From B31.8 Emergency Planning and Response	detection and pipe shutdown capabilities • the type of gas being transported • operating pressure • the rate of potential release • pipeline profile • the potential for ignition • location of nearest response personnel • Inspectors should review examples that the of implementation of the process to determine the appropriateness of conclusions reached on the need for, or lack of need for, the installation of automatic shut-off valves or remote control valves.	
III. Safety Assurance- The "Check" Phase, leading to "Act"	9. Performance Plan: Plan evaluations performed at least annually. 9.2 Characteristics: Measures simple, measurable, attainable, relevant, and permit	I. Performance Measures Inspect the operator's program to verify that as a minimum, provisions exist for measuring integrity management program effectiveness in accordance with the four elements of B31.8S -	Provide more formality, cohesion, emphasis and detail for the safety assurance process by uniting previously disparate elements in one structure. Ensures senior management review takes place on a regular basis. Greater cohesion and integration enables

Element	B31.8S Standard	CFR 192 and Gas Integrity Management Inspection Manual : Inspection Protocol with Supplemental Guidance, Jan 1, 2008, Rev. 5	Recommendations for Management System
	timely evaluations. Must be reasonable program effectiveness indicators. Measures can be process or activity, operational, or direct integrity measures; i.e. how well an operator is implementing various elements of the program, how well the system is responding to IMP, and leaks, ruptures, injuries and fatalities, respectively. Lagging measures are reactive; leading are proactive and indicate how well plan may be expected to perform. 9.4 Measurement Intrasystem: methods include threat specifics, normalized, internal benchmarking among segments, and internal auditing, with suggested starting points, and preference for not direct involvement by auditor. 9.5 Measurement Industry based includes benchmarking, industry wide data sources but based on valid comparisons. 10. Communications: Inform externally and internally about IMP efforts and results. Operator management and other appropriate operator personnel must understand and support, including metrics.	2004, Section 9.4 and each identified threat in Appendix A 192.945c F.01 Periodic Evaluation Verify the operator conducts a periodic evaluation of pipeline integrity based on data integration to identify threats specific to each covered segment and the risk represented by these threats. 192.917 and 192.937 (b) Verify that the operator's IMP requires the completion of periodic evaluations and reassessments of covered segments after completing the baseline integrity assessment. An operator must base the frequency for conducting periodic evaluations and the reassessment interval on risk factors specific to its pipeline, including at least the past and present integrity assessment results, risk analysis results, and decisions about repair, and preventive and mitigative actions taken to reduce risk. Periodic "evaluations" involve a different process than "assessments." Evaluations are analytical reviews of a wide range of data and information regarding the pipeline integrity that includes but goes beyond simply "assessment" results. "Assessments" of pipelines on the other hand are tests, or actual measures of the pipeline's	these functions to be applied more comprehensively and systemically for greater integrity effectiveness, with more attention to operational processes Develop more quantitative means of verifying safety and integrity performance and effectiveness of risk controls, reviewed regularly, high level, directly related to issues at hand. Structure of measures follows model of the triangle – safety, level one; processes performance, level two; continuous improvement, level three. Continuously monitors operational data, including vendor/contractors, for effectiveness of controls. Assures objectivity of evaluations through enhanced use of periodic internal audits and peer review of the IMP. Provides more formality and specificity in the audit program through criteria, scope, frequency and methods documentation. Plan will be reported and records of corrective actions maintained and tracked on multi-level basis, including who at leadership level. Dedicated, qualified audit resource identified. Enhances QA/QC process. Corrective action plan and process should be transparent to employees so they can see and know the organization is doing the corrections. Maintain a library of corrective actions as a data base of risks that shows status and other data. Self-assessment, peer review, expert third party – taking responsibility for the "Check" phase in Plan, Do, Check, Act. System assessment is performed for conformance to policy and targets set by management, determines how well

Element	B31.8S Standard	CFR 192 and Gas Integrity Management Inspection Manual : Inspection Protocol with Supplemental Guidance, Jan 1, 2008, Rev. 5	Recommendations for Management System
	12. Quality Control: Documented proof that the operator meets all the IMP requirements. Identify processes, their sequence and interaction; criteria and methods; resources and information needed; monitor .measure and analyze; implement actions to get results and improvement. Determine documentation, responsibility and authority, qualification, how to monitor; use of internal and possible independent third party review; document corrective action; and control of outside resources for quality. 11. MOC: Formal understandable procedures to identify impact of change major and minor technical, physical, procedural and organizational, whether permanent or temporary. Includes reason, authority, analysis, acquisition of work permits, documentation, communication to affected time limits, qualifications. Equipment and new technology of special concern. From B31.8 -Incident Investigation	condition and can be performed using a variety of tools or inspection techniques. F.01.a The inspector should verify that the data from the entire pipeline is considered and not just data from covered segments. Furthermore, an operator is only required to gather and integrate existing data about its pipeline system, i.e., the data does not have to be created if it does not exist. The inspector should verify that the periodic evaluations consider cyclic fatigue and other loading conditions (including ground movement, suspension bridge condition) that could lead to failure of a deformation, including dent or gouge, or other defect in a covered segment. Verify that the evaluation assumes the presence of threats in the covered segment that could be exacerbated by cyclic fatigue. 192.917(e)(2) K. Management of Change (MOC) K.01Verify that changes to IMP have been handled in accordance with 192.909. K02Verify that IMP meets the requirements B31.8s for a MOC process. 192.911(k) ASME B31.8S-2004, Section 11 contains the provisions for what constitutes an acceptable management of change process.	processes, technology and people are working against objectives. A technology advancement plan is in place. Develops and maintains an MOC process to identify changes within operations which may affect established processes and describes arrangements to assure safety and integrity before implementing change. Includes new system design, changes to existing, new operations and modified operations Continuous improvement focus is enhanced by more mature process to identify causes of substandard performance, areas where improvement can be made and results for tracking change needed to maximize quality. Reviews for opportunities for improvement, adequacy of risk control, effectiveness of policy, audit and evaluation results .Develops preventive/corrective actions to promote continuous improvement. Communicates continuous improvement findings throughout system and promotes lessons learned, prioritizes actions, trends from data analysis.

Element	B31.8S Standard	CFR 192 and Gas Integrity Management Inspection Manual : Inspection Protocol with Supplemental Guidance, Jan 1, 2008, Rev. 5	Recommendations for Management System
	-Document Management - Continuous Improvement	K02 Operators may have a special set of procedures that describe change control as it applies to integrity management, or it may have an existing change control process that incorporates the aspects of integrity management. The management of change process specified in ASME B31.8S-2004, Section 11 addresses both program changes and physical/design changes. It should be noted that changes in the integrity management program can drive physical changes to the pipeline, and changes to the pipeline can affect the integrity management program in areas like risk analysis and assessment methods. K.02.a. Verify the existence of procedures that consider impacts of changes to pipeline systems and their integrity. [ASME B31.8S-2004, Section 11(a)] K.02.a. Supplemental Guidance: ASME B31.8S-2004, Section 11 requires procedures to be in place to control changes such that the affect on pipeline integrity is considered. This could be implemented by ensuring the appropriate review of proposed changes by pipeline integrity personnel. Examples of changes that must be considered include, but are not limited to: • New gas streams coming online (for example, new	

Element	B31.8S Standard	CFR 192 and Gas Integrity Management Inspection Manual : Inspection Protocol with Supplemental Guidance, Jan 1, 2008, Rev. 5	Recommendations for Management System
		wells) that increase the BTU heat value of the transported gas (change from lean to rich gas) • Pipeline reroutes that place the pipeline closer to identified sites • An increase in pipeline MAOP that results in a larger potential impact circle • Pipeline modifications affecting piping diameter that results in a larger potential impact circle • Corrections to erroneous pipeline center line data L Program Requirements for the Quality Assurance Process. Verify that a QA process exists that meets the requirements of B31.8S – 2004 Section 12. 192.911(l) QA requirement references B31.8S M. Communications Plan Verify that an IMP communications plan exists that meets the requirements of B31.8s Section 10. 192.911(m) Internal and external communications requirement references B31.8S	

Supporting Research

Management systems provide a framework for highlighting straightforward failure modes resulting from third party damage, corrosion or pipe quality for example and they can also provide insight into risks associated with weaknesses in other programs. The FAA ties Safety Management Systems and to preventing organizational accidents.

Programs such as Integrity Management (IMP), Health Safety and Environment (HSE) (including Incident Mitigation Management), Control Room Management, and Quality Management (QMS) are set up as barriers/layers of defense to incidents. Research indicates that organizational accidents rarely occur due to the breakdown of a single program; they are usually the result of breakdowns of multiple programs.

A review of research by James Reason and Phil Hopkins provides context for operators to consider as they develop their management systems. These highlights are not meant to represent complete compendium of the research.
Research by James Reason describes Organizational Accidents as:

- Comparatively rare, often catastrophic events within complex modern technologies (nuclear, aviation etc.)
- have multiple causes involving many people,
- devastating effect on uninvolved populations, assets and environment
- difficult to understand and control
- hard to predict
- seem to occur "out of the blue"

In his paper, "Why Failures Happen and How to Prevent Future Failures", Phil Hopkins indicates that:

- a complex combination of problems, in particular deterioration with time and changing conditions, human errors and safety culture contribute to failures
- Pipelines will always pose some level of risk and the challenge is to control risk to a reasonable level
- In addition to a focus on formal integrity management focus on:
    - process safety
    - risk management
    - staff competency
    - 'Best practices'
    - Including more 'leading' safety indicators, such as near-misses in addition to traditional lagging indicators.

Management systems approach can be used not only to assess performance of individual programs but also to assess how programs link together to form layers of protection.

Brief History of Management Systems and Use in Other Industries

The concept of a "management system" has its roots in manufacturing and the inspection of products to identify defects. The concept of "processes" was included in quality practices at the beginning of the 20th century, and the use of statistics to control quality processes in manufacturing emerged in the years leading up to World War II. W. Edwards Deming and others championed the use of statistical methods in for producing commercial products in Japan in the years after WWII. The subsequent Total Quality Management movement in the US emphasized not only statistics, but quality control processes that embraced the entire organization.

Several other quality initiatives followed, including the publication of the ISO 9000 series of quality-management standards in 1987 and the establishment of the Baldrige National Quality Program and Award by the U.S. Congress in that same year. In the 1990s, a number of sector specific ISO sector-specific versions of the ISO 9000 quality management system were developed in various industries (automotive, aerospace, and telecommunication) and for environmental management (ISO 14000).

In addition to these voluntary standards, management systems concepts began to be integrated into government regulation in the 1990's (e.g., OSHA's 1992 process safety management standard and EPA's Risk Management Program Regulation in 1993.). In this period industry associations and corporations also began implementation of standards for managing various processes that integrated management systems concepts.

Industries and companies did this for a number of reasons, including:

- Meet expectations of customers, employees, shareholders and the public
- Prioritize activities based on risk -- recognize it is not practical to envision and develop procedures for all possible adverse events
- Achieve more comprehensive integration and alignment with goals, policy, programs and processes linked to planned resource allocation
- Improve operational effectiveness and efficiency in a way that is continuous and sustainable
- Achieve multidimensional performance – i.e., economic, socially-responsible and operationally effective

These industries were able to move to management systems by setting a common goal, starting small and evolving over time. First, they set out with a common goal – a clear commitment to improve performance steadily over time, which became fundamental to their business model. They also started small with a focus on turning data into good information to fuel good decisions on opportunities to improve, and recognized the management systems are a journey that takes time. They continued to evolve these systems over time - building on common set of elements, linking goals, processes and resources, and empowered by senior leaders, policy, programs, accountability, a strong culture, and stakeholder engagement. As the systems matured, the industries worked to accommodate disparate existing systems, synchronized different requirements, and implemented improvement in an increasingly comprehensive, integrated and systemic way. These industries also fostered participation and recognized varying levels of maturity across the industries.

Just as continuous improvement is a critical element in an organization's management system, the field of management systems has continued to evolve over time. An important development has been the recognition of the importance of interactions and connections between functional areas in organizations. For example, in the late 1990s there were quality management systems, environmental management systems, personal safety management systems, etc. A number of organizations have now adopted integrated management systems that define more holistic management processes for identifying risk and determining how risks are mitigated and controlled.

References

- Byrd, W.R. *Safety Improvement Programs: A study of Activities in Various Industries*, 2012
- "*Safety Management System, SMS Explained*", 2009, Federal Aviation Administration. Date of access: 2012, http://www.faa.gov/about/initiatives/sms/explained/
- Hopkins, Phil. "*Why Failures Happen and How to Prevent Future Failures*", 2012
- Reason, James. *Managing the Risks of Organizational Accidents*. Burlington, Vermont, 2000
- Abes, Jake. "*Safety and Loss Management System for Pipelines*". Journal of Pressure Vessel Technology, 2008